POLITÉCNICA "Ingeniamos el futuro"

citSem POLITÉCNICA Centro de Investigación en Tecnologías del Software y Sistemas Multimedia para la Sostenibilidad

Universidad Politécnica de Madrid

SIGNAL 2023

Supervised Spatial Divide-and-Conquer Applied to Fish Counting

National Project : Aquaculture 4.0: Application of vision and artificial intelligence technologies to improve the production process

Presenter:

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March 13, 2023 to March 17, 2023 - Barcelona, Spain

Counting objects in images.

- Frequent task in industrial and scientific areas

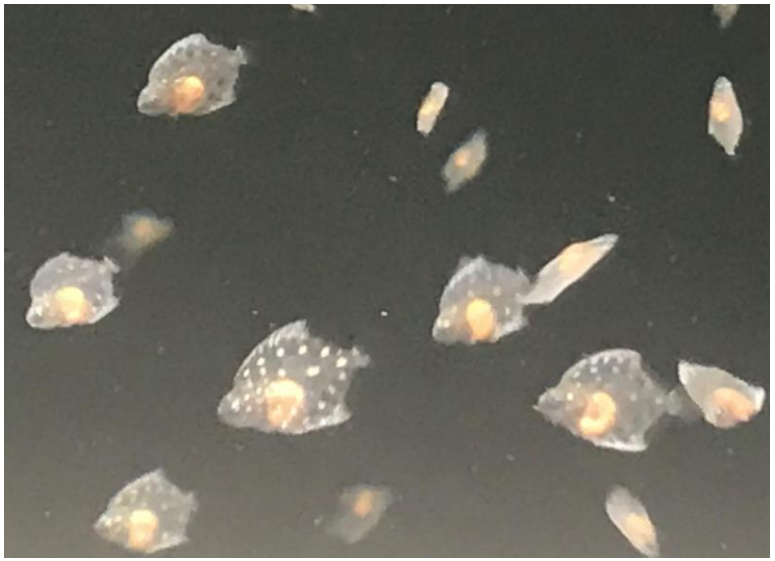
- In aquaculture is applied to know number of fishes in a image

Biomass estimation

- Optimize the amount of feed
- Plan later stage of farming
- Make decisions at the right times

Aquaculture 4.0

Larvae turbots



Adult turbots

GOAL

Idea

- The application of ML algorithms to images of fish larval tanks can enable the implementation of low-cost, accurate, and reliable biomass estimation systems.

Goal

- A system that allows obtaining an estimated number of turbot larvae present in RGB images based on a deep learning algorithm.

Artificial vision algorithm.

Approaches to count the number of objects in an image

Detection

- Position of the objects
- Problems when the objects are overlapping

Regression

- Supervised machine learning techniques
- Requires large datasets to be trained

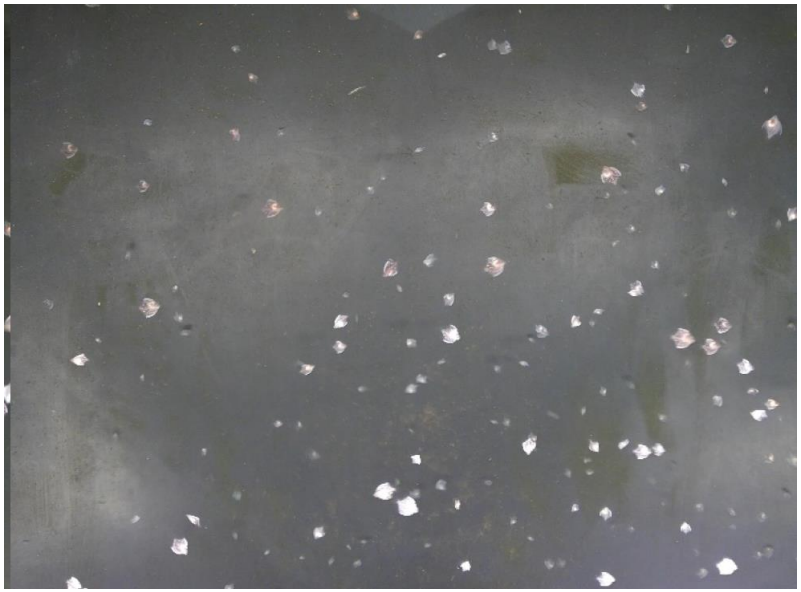
Density estimation

- Distribution of the objects
- Adaptable to objects with different sizes

Dataset. Experimental scenario.

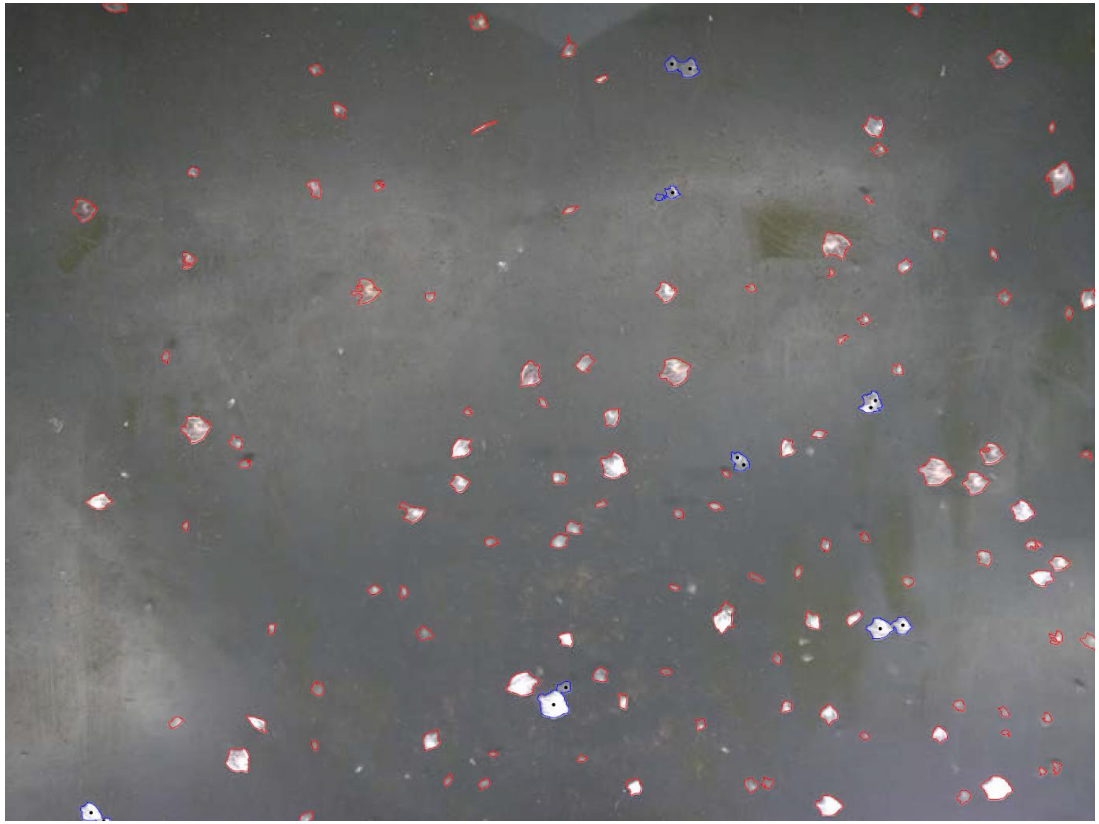
- RGB camera, Reolink
- Located with the lens axis perpendicular to the water

Dataset. Images.



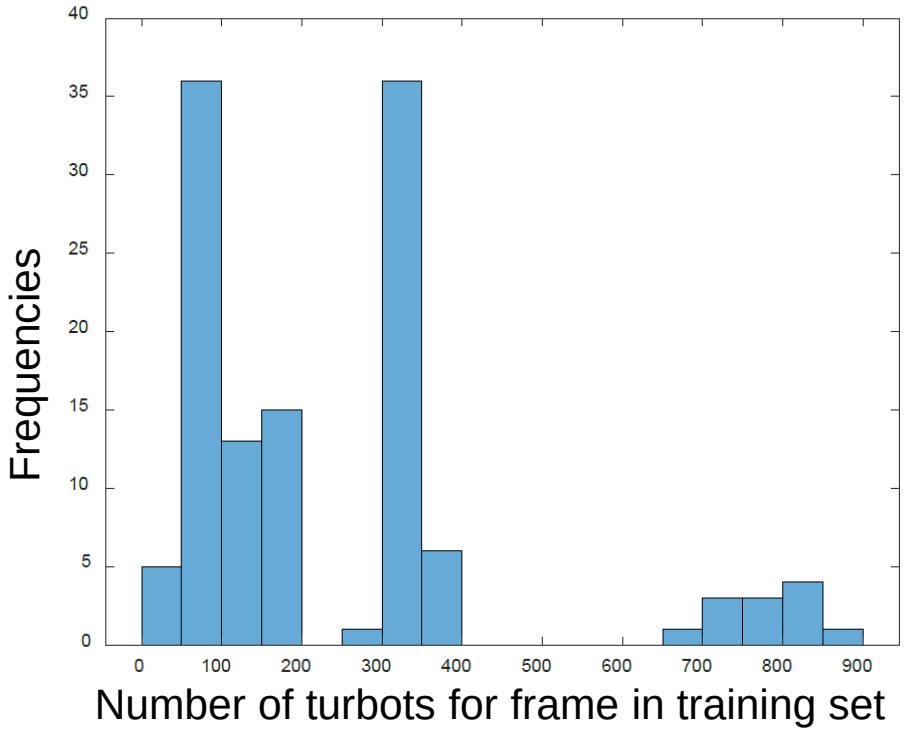
- 156 images of turbot larval tanks
- RGB images, 2560x1920 pixels resolution
- Different densities of fishes

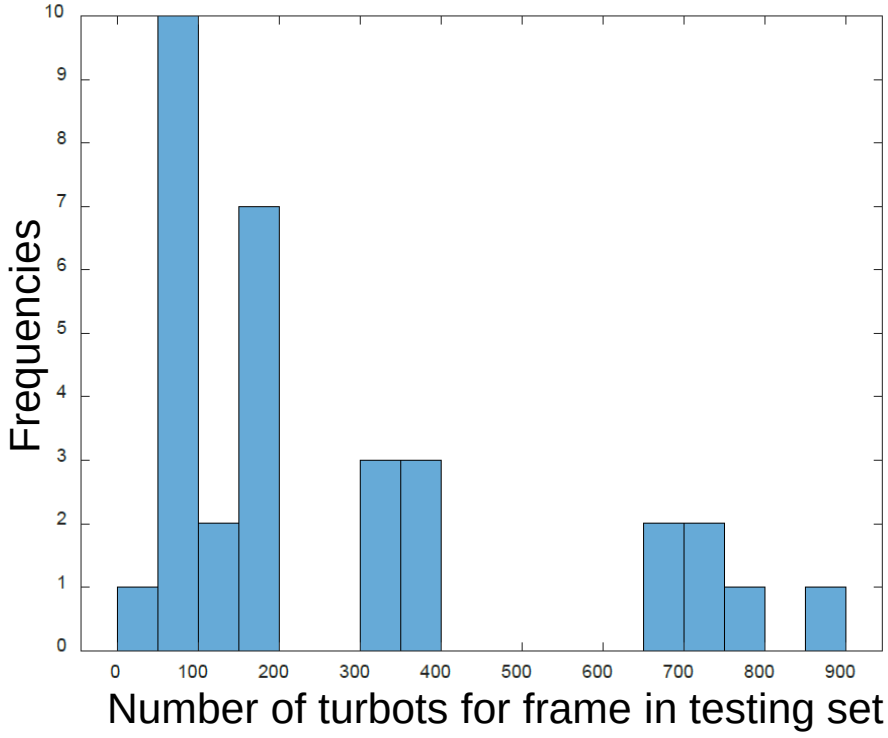
Dataset. Annotation of images.



- Initial segmentation by thresholding
- Manually revised to generate the ground-truth

Dataset. Train and test sets



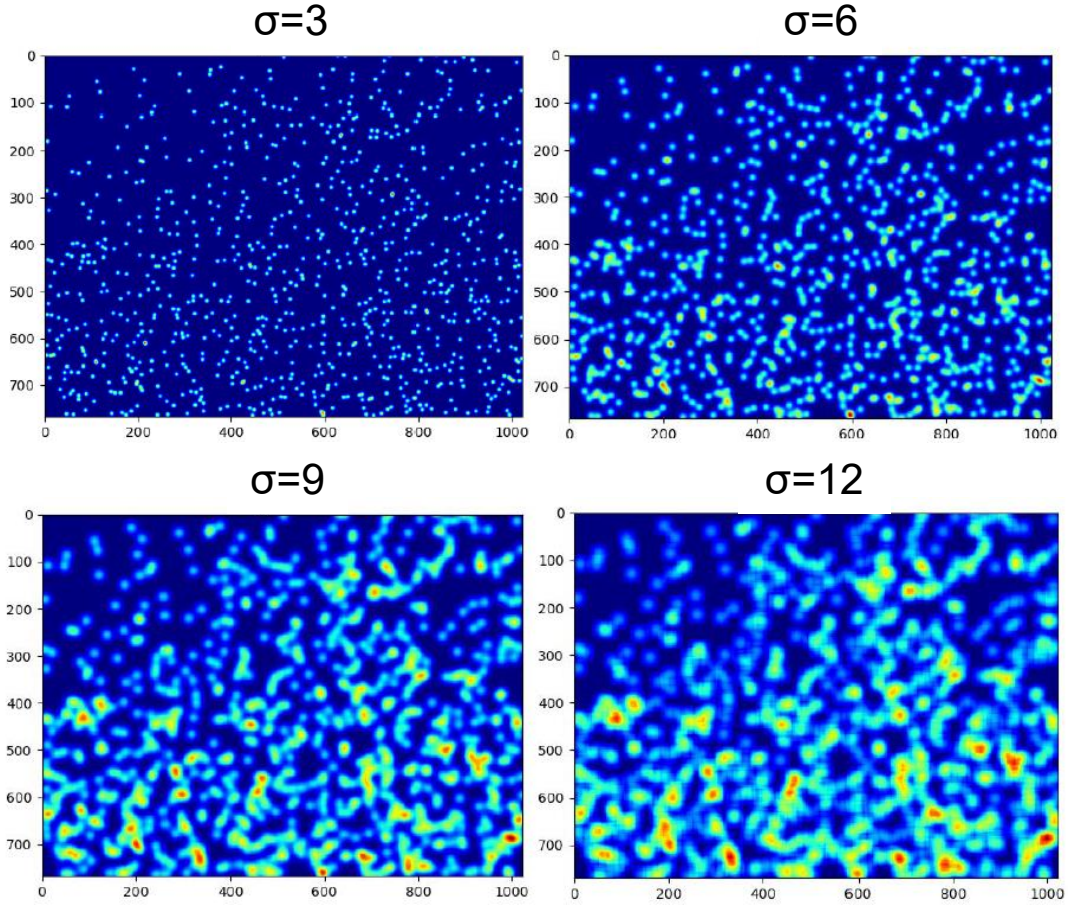


- 124 images (80%) for training and 32 images (20%) for testing

Neural Network. SS-DCNet

- **S**upervised **S**patial **D**ivide-and-**C**onquer for Object Counting model.
- Learns from a **closed set** and generalizes to scenarios with **open sets**.
- Generate multi-resolution feature maps in sub-images of 64×64 pixels.
- Estimate the **density map** related to sub-image selected.
- Density map is used to calculate the local count.

Relationship between σ and density map

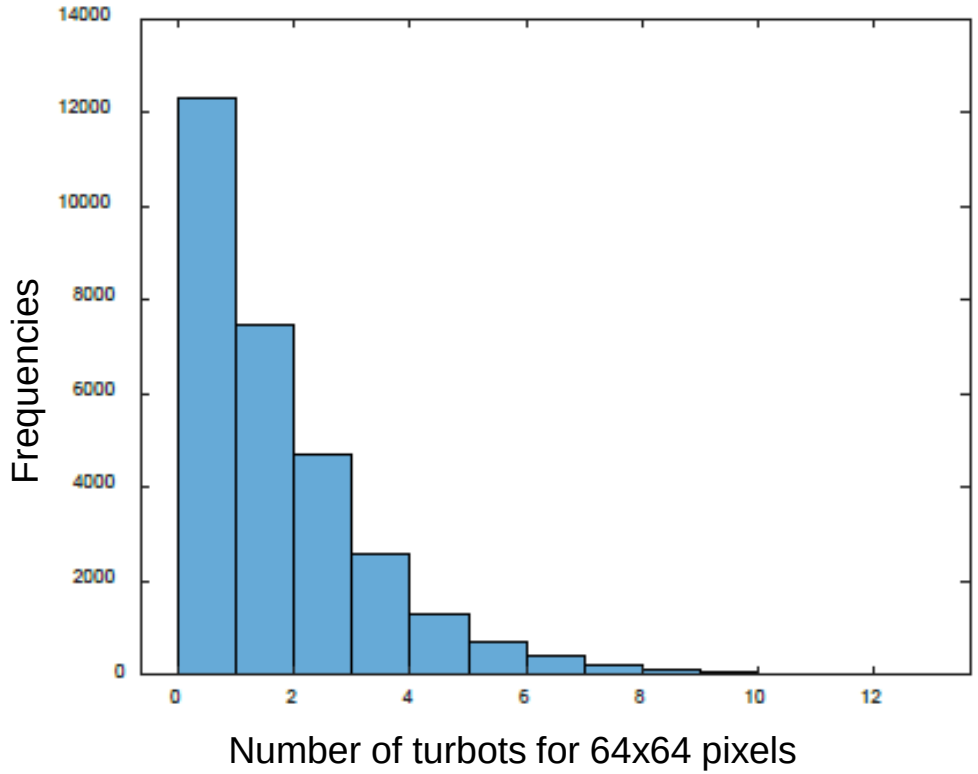


- A value of 12 was used for σ to create the density maps

MAE = 9.66 RMSE = 18.20 MAPE = 3.48%

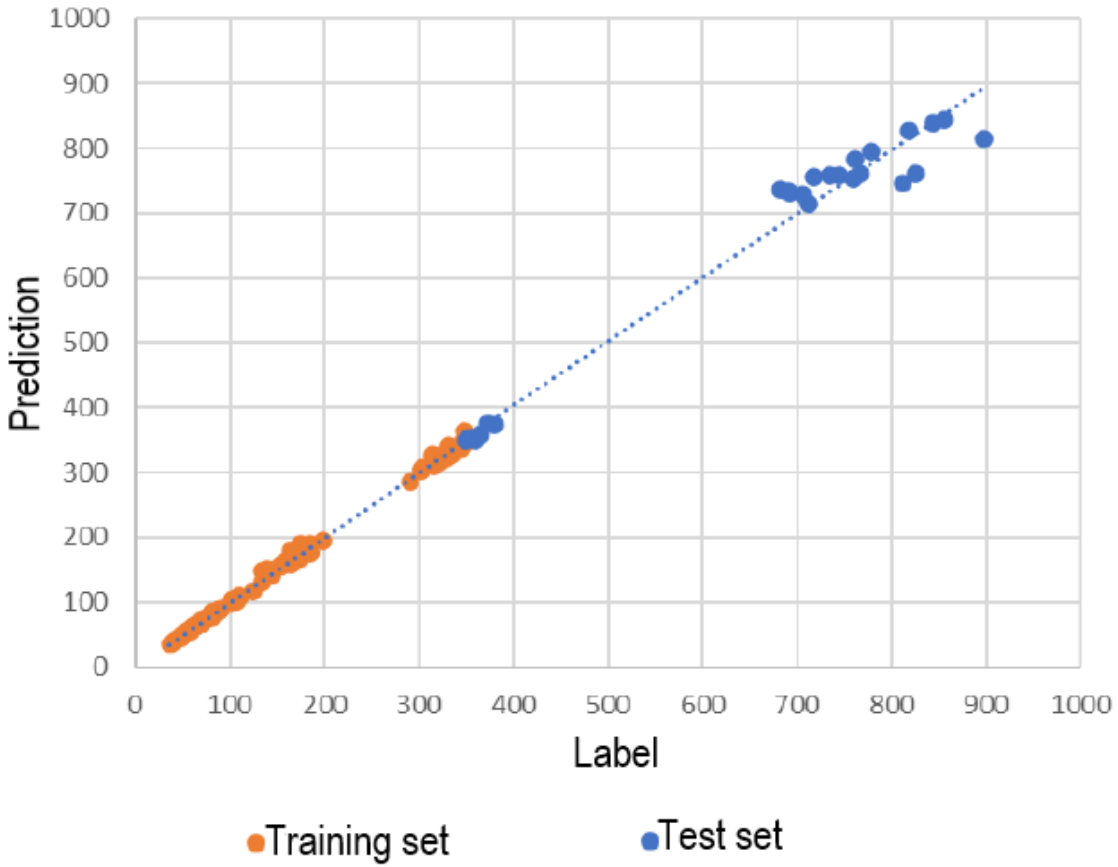
Selection of C_{max} value

- C_{max} = 5 corresponding to the 95th percentile of the objects distribution in 64 × 64 pixels



MAE = 9.66 RMSE = 18.20 MAPE = 3.48%

Generalization capability / ability



- Re-trained with images that had a low density (less than 350) and tested with images that had a high density (350 – 898).
- 129 and 27 images were used for training and testing, respectively

Conclusions

- Mean error lower than 3.5%
- Adaptation of the model to count other fish species, not necessary to use large datasets for training
- Generalization ability
- Adjusting the value of σ for each labeled point based on the morphological features

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Thank you!!

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